

## A taxonomic revision of the Western Australian genus *Lysiosepalum* (Malvaceae: Lasiopetaleae)

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### Abstract

Wilkins, C.F. & Chappill, J.A. A taxonomic revision of the Western Australian genus *Lysiosepalum* (Malvaceae: Lasiopetaleae). *Nuysia* 13(3): 571–594 (2001). A taxonomic revision of *Lysiosepalum* F. Muell., a genus endemic to south-western Australia, identified five species. These comprise two currently accepted species *L. involucreatum* (Turcz.) Druce and *L. rugosum* Benth., the reinstated *L. hexandrum* (S. Moore) S. Moore and two new species *L. abollatum* C.F. Wilkins (CALM Priority One) and *L. aromaticum* C.F. Wilkins (CALM Priority Two) that probably require recognition as Declared Rare Flora.

A cladogram based on morphological data indicates that *Lysiosepalum* is a monophyletic genus, strongly supported by three synapomorphies unique in tribe Lasiopetaleae: calyx tube very short (lobes scarcely fused at the base); calyx lobes of alternating broad and narrow widths; epicalyx bracts equally spaced to completely enclose the mature bud.

A chromosome number of  $n = 10$  for *L. involucreatum* is the first published record for the genus.

### Introduction

*Lysiosepalum* F. Muell. is an endemic south-western Australian genus of five species. It has traditionally been placed in Sterculiaceae, but this family is now included in the greatly expanded Malvaceae (*sensu* Judd & Manchester (1997), supported by Alverson *et al.* (1998), the Angiosperm Phylogeny Group (1998) and Bayer *et al.* (1999)). *Lysiosepalum* belongs to the tribe Lasiopetaleae (Gay 1821) a group characterized by being apetalous or having much reduced scale-like petals, having subulate non-petaloid staminodes and non-versatile anthers with contiguous, connate lobes.

Mueller (1859) named the genus from the Greek – *lysis*, meaning loosening or releasing and the Latin – *sepalum*, meaning sepal (Brown 1954), in reference to the almost free calyx lobes. The genus was typified by *Lysiosepalum barryanum* and the epithet honoured Redmond Barry, then Chancellor of Melbourne University. However, Turczaninov (1852) had already described this species as *Thomasia involucreata*, which Druce (1917) subsequently transferred to *Lysiosepalum* (*L. involucreatum*).

*Thomasia involucrata* was described correctly as six-merous by Turczaninov (1852), however, the usually hexamerous feature of *Lysiosepalum* was not consistently recognized in following treatments. Mueller's (1859) generic description stated that *L. barryanum* was five-merous, rarely having six stamens and sepals, and Bentham (1863) erroneously described *L. rugosum* as five-merous. Type specimens and other collections of these original species of *Lysiosepalum* are, however, all six-merous. Confusion was still apparent when Moore (1921) described a third new species *Thomasia hexandra* Moore, the epithet referring to the six-merous flowers. When he later examined *Lysiosepalum* held at BM and Australian herbaria (unnamed), he found them to be hexamerous and subsequently transferred the taxon to *Lysiosepalum* (Moore in Sargent 1923). This species, although currently not recognized (Hnatiuk 1990), having previously been reduced to synonymy of *L. involucratum* (Blackall & Grieve 1956), is reinstated here as a distinct species. Of the two additional species described in this revision, one is 6-merous and the other is 4- or 5-merous.

As there has been no comprehensive treatment of *Lysiosepalum* since "Flora Australiensis" (Bentham 1863), this paper presents a formal revision of the genus as part of a revision of Lasiopetaleae in preparation for "Flora of Australia" Volume 7. In addition, a lack of published information on anatomy, cytology and phylogeny of the genus is redressed.

### Methods

This revision is based primarily upon morphological evidence obtained from examination of vegetative, and fresh and rehydrated flowering material from collections, including type specimens, from the following national and international herbaria; AD, BM, BRI, CANB, CBG, DNA, K, MEL, NSW, P, PERTH, W. All defined taxa have been examined in the field.

Seed-coat morphology was examined on seeds from the authors' field collections, or those of Kings Park Botanic Garden (KPBG). Examination of pollen exotesta of *Lysiosepalum involucratum* (KPBG 196/86, identity verified from seedlings) was facilitated by an Environmental Scanning Electron Microscope (Danilatos 1993). Seedlings were grown of *L. hexandrum* (C.F. Wilkins 737), *L. involucratum* (KPBG 196/86) and *L. rugosum* (C.F. Wilkins 732). Seeds were pre-treated by being covered with boiling water and soaked overnight. Seeds were germinated in petri dishes on filter paper moistened with 1% Previcur fungicide and those with emergent radicles were transferred to pots of potting mix in a glasshouse.

*Anatomy and cytology.* Anatomical comparison of fresh plant material was facilitated by fixing in glutaraldehyde, embedding in GMA resin, sectioning by microtome and staining with Toluidine Blue pH 4.4 (Feder & O'Brien 1968). To observe chromosome number, fresh anthers were fixed in 3:1 absolute ethanol: glacial acetic acid for 24 hours, rinsed in 70% ethanol and stained in alcoholic hydrochloric acid carmine for two days. Anthers were squashed in 45% glacial acetic acid and chromosomes from meiotic pollen mother cells were micrographed using a Zeiss Axiophot microscope and 6 ASA Imagelink film.

*Cladistic analysis.* A data set of five identified species of *Lysiosepalum*, two outgroup taxa and 25 morphological characters was established in MacClade 3.05 (Maddison & Maddison 1992). *Thomasia angustifolia* Steud. and *Guichenotia angustifolia* (Turcz.) Druce were chosen as outgroup taxa as a cladistic analysis of all species of Lasiopetaleae (unpublished data) shows *Lysiosepalum* to be monophyletic and *Guichenotia* and *Thomasia* to be closely related with similar stipules, and anthers dehiscenting by apical pores. The outgroup species chosen retain the plesiomorphic features of these

genera. Binary and both quantitative and qualitative multistate characters were included (Table 1). Multistate characters which represented logical progressions in size or shape were treated as ordered, while the remainder were left unordered. Where more than one character state was present within a taxon, the taxon was coded as polymorphic. The resulting data matrix is presented (Table 2).

Character definitions are self-explanatory except for character 5 where crisped margins are defined as being wavy or undulate, character 14 where hair density is defined as scattered when the hairs are well separated, medium density when the hairs are just touching laterally, dense when the hairs are strongly overlapped with the epidermis remaining visible, and tomentose where hair density conceals the epidermis. For character 19 anther pores are described in this revision as being in the apical position, but they may originate basally. A study of anther development (Heel 1966) in *Thomasia*, which is similar in anther morphology to *Lysiosepalum*, showed the anther being resupinate in early development. In this study, the terminal pores are treated as being homologous in *Thomasia*, *Guichenotia* and *Lysiosepalum*.

Table 1. Characters scored for five *Lysiosepalum* and two outgroup taxa. Multistate characters 2, 4, 8, 12, 14, 16, 20, 22 were ordered and the rest were unordered. Consistency and retention indices from the single shortest tree, are indicated in brackets for each character.

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1. Adult leaf orientation: 0 = horizontal or reflexed; 1 = erect (1.0, 1.0).
  2. Adult leaf petiole length: 0 = 6–4.6 mm; 1 = 4.5–3.1 mm; 2 = 3.0–1.6 mm; 3 = 1.5–0 mm (0.8, 0.667).
  3. Adult leaf base: 0 = attenuate; 1 = cordate (1.0, 0.0).
  4. Adult leaf margin: 0 = flat; 1 = recurved; 2 = revolute (1.0, 1.0).
  5. Adult leaf margin: 0 = straight; 1 = crisped/wavy (0.5, 0.5).
  6. Adult leaf shape: 0 = broadly ovate; 1 = narrowly ovate; 2 = narrowly elliptic; 3 = linear (0.857, 0.667).
  7. Flower: 0 = 4–5-merous; 1 = 6-merous (1.0, 1.0).
  8. Glandular hairs on pedicel: 0 = absent; 1 = 0.1–0.4 mm long; 2 = 0.5–0.9 mm long (0.5, 0.333).
  9. Bracteoles in bud: 0 = not enclosing mature bud; 1 = enclosing mature bud (1.0, 1.0).
  10. Bracteole fusion: 0 = absent; 1 = shortly fused at base (1.0, 1.0).
  11. Bracteole shape: 0 = narrowly ovate or narrowly elliptic 3:1 or more; 1 = ovate 2.5:1 or less (1.0, 1.0).
  12. Stellate hairs on bracteole adaxial surface: 0 = scattered; 1 = medium density; 2 = dense; 3 = tomentose (1.0, 1.0).
  13. Stalked, clavate glands on abaxial surface of bracteole: 0 = absent; 1 = present (0.5, 0.0).
  14. Stellate hairs on bracteole abaxial surface: 0 = medium density; 1 = dense hairs; 2 = dense tomentum (1.0, 1.0).
  15. Number of arms in stellate hair on bracteole abaxial surface: 0 = 12–c.25; 1 = 2–12 cells (1.00, 0.0).
  16. Calyx lobes as a % of total calyx length: 0 = 61–70; 1 = 71–80; 2 = 91–100 (1.0, 1.0).
  17. Calyx lobes: 0 = equal widths; 1 = alternating broad and narrow (1.0, 1.0).
  18. Petals: 0 = present; 1 = absent (1.0, 0.0).
  19. Anther dehiscence: 0 = pore only; 1 = pore and split from pore to anther base (1.0, 0.0).
  20. Degree of fusion of anther lobes: 0 = completely fused; 1 = shallow groove; 2 = strongly grooved (1.0, 0.0).
  21. Filament width: 0 = 0–0.3 mm; 1 = 0.4–0.5 mm (1.0, 1.0).
  22. Staminal tube: 0 = absent; 1 = less than 1 mm; 2 = more than 1 mm (1.0, 1.0).
  23. Brittle ovary hairs: 0 = absent; 1 = present (1.0, 1.0).
  24. Base of brittle hairs: 0 = short fused base < 50 % fusion; 1 = long fused base > 50% fusion (1.0, 1.0).
  25. Number of ovules per locule: 0 = 1–8; 1 = more than eight (1.0, 1.0).
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Table 2. Data matrix for a cladistic analysis of *Lysiosepalum* and two outgroup species in *Guichenotia* and *Thomasia*. Missing data are coded as ‘?’.

Taxon	12345	1 67890	11111 12345	11112 67890	22222 12345
<i>Guichenotia</i>	01010	11000	00000	00000	000?0
<i>angustifolia</i>	2 2	3	1	1 1	
<i>Thomasia</i>	02000	21000	00100	00102	000?0
<i>angustifolia</i>	1	3		1	
<i>Lysiosepalum</i>	03011	12111	10101	21012	10101
<i>abollatum</i>	1 1		1 1		1
<i>L. aromaticum</i>	00111	00211 1	10110	21002	00100
<i>L. hexandrum</i>	13020	32211	12120	21002 1	11111 2
<i>L. involucreatum</i>	13020	32111	12120 3	21002 1	11111 2
<i>L. rugosum</i>	01011 1 1	12011	10010 1 2	21012 1	00101 11

Phylogenetic relationships were determined using the program PAUP 3.1.1 (Swofford 1993). The outgroup method (Watrous & Wheeler 1981) was used to polarize characters. Character states were equally weighted for a branch and bound search to look for equally parsimonious trees. Bremer support (Bremer 1994) and bootstrap frequencies (Felsenstein 1985) were used to estimate stability of each node. The total support index *Ti* (Bremer 1994) was determined by summarizing all Bremer support values for nodes in the cladogram and then dividing the sum by the obtained tree length. A bootstrap analysis (branch and bound) was performed with 1000 replicates.

## Results and discussion

Examination of herbarium specimens and fresh material revealed five discrete taxa in *Lysiosepalum*. These are each sufficiently distinct to be recognized as species.

*Inflorescence structure.* *Lysiosepalum* inflorescences have been incorrectly described as axillary (Mueller 1859) and as racemes (Mueller 1859, Bentham 1863, Moore 1921). Actually they have leaf-opposed, monochasial cymes with 2–12 flowers frequently oriented towards one side of the inflorescence. This study confirms the inflorescence form of *Lysiosepalum* is as described from one species *L. involucreatum*, by Bayer & Kubitzki (1996). The flowering shoots are sympodia with repeating units of two or three vegetative nodes and a terminal inflorescence that is overtopped by the axillary product of the distal leaf which leads to a leaf-opposed inflorescence (Figure 1). This study also confirms that *Lysiosepalum* has the basic repeating *bicolor* unit (Bayer 1999, after *Theobroma bicolor* where it was first observed) which is a synapomorphy for the core Malvales (now circumscribed as Malvaceae, *sensu* Judd & Manchester 1997). The *bicolor* unit is determinate and bears three bracts, one of which is sterile



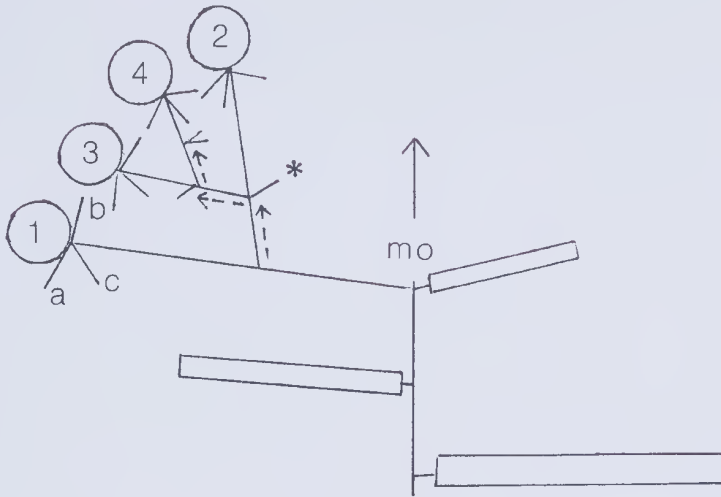


Figure 1. *Lysiosepalum* sympodium with two vegetative nodes and the terminal inflorescence overtopped by the axillary module (mo) of the distal leaf leading to a leaf opposed inflorescence. The monochasial cyme numbers indicate flower order; a,b,c is the epicalyx of the terminal flower (1); broken lines indicate displacements; \* is the displaced subtending bract of second flower (after Bayer & Kubitzki 1996).

and the other two subtend lateral cymes, or in single flowers it can be reduced to an epicalyx of three sterile bracts (Bayer 1999). In *Lysiosepalum* flowers have an epicalyx of three sterile bracts, the first flower has no subtending bract (Figure 1), which Bayer & Kubitzki (1996) state indicates it is the terminal flower of the inflorescence. The subtending bract of the second and subsequent flowers are situated more distally which Bayer and Kubitzki regard as recaulescent displacement.

All except the new species *L. aromaticum* have occasionally been observed with a dichasial cyme co-occurring on the flowering stem with the unbranched cymes. *Lysiosepalum* also has the feature of consistent retention from the previous flowering season of the peduncle and inflorescence stem (without pedicels) which is also observed in some *Thomasia*. They are present on the stem below the flowering, new seasonal growth units.

**Seed and seedling morphology.** Seed morphology of *Lysiosepalum* is similar to *Thomasia*, *Guichenotia* and *Lasiopetalum* in having sessile, stellate hairs on the testa, and cap-like arils with two longer lobes extended on the hilar surface. *Lysiosepalum* seed has a smooth surface to the naked eye but Environmental Scanning Electron Microscopy revealed the exotesta of *L. involucreatum* and *L. rugosum* to be patterned with longitudinally-elongated, narrowly oblong, epidermal cells. Seed anatomy conforms to Malvales (Corner 1976) in having an exotegmic palisade (detailed description of seed coat and anatomy, Wilkins in prep).

*Lysiosepalum* seedlings show epigeal, phanerocotylar germination with cotyledons that are petiolate, green, elliptic, entire, glabrous, flat and slightly expanding after germination. First and subsequent leaves of observed species are alternate and entire. The first five leaves are ovate and flat, while from the sixth to seventh node, leaves are oblong, flat and up to four times larger than adult leaves. Progressively they become smaller, more linear and margins recurve, which is the mature form of the

leaf and stipule. In addition, seedling leaves in the glasshouse and in the field, have larger, more scattered, stellate hairs than those present on leaves of mature plants. Stipules are absent on the first two leaves and develop at the third leaf node in all species examined and at that stage seedlings are 1.5–3 cm high.

**Anatomy.** Transverse sections of leaves of *L. hexandrum* (K.A. Shepherd 68, J.A. Wege 264) and *L. abollatum* (C.F. Wilkins 1213), show them to be dorsiventral. In the uniseriate epidermis there are single cells or groups of cells (Figure 2A) that are larger than the remaining epidermal cells and stain reddish-purple. These are considered to be mucilage cells, as Toluidine Blue stains polycarboxylic acids, including alginic and pectic acid, reddish-purple (Feder & O'Brien 1968). Mucilage cells and canals are reported as characteristic of Malvaceae *s.l.* (Metcalfe & Chalk 1950)). The palisade layer is biseriate or with a poorly organized third layer and the spongy mesophyll cells are loosely packed with obvious air spaces. A bundle sheath around secondary veins is uniseriate (Figure 2B) and consists of moderately thick-walled, achlorophyllous parenchyma. Primary veins are surrounded by two layers of thick-walled parenchyma cells and a crescent of fibres is present directly below the phloem. Species examined are hypostomatic with guard cells that have mucilage inclusions. Crystal druses are present as cell inclusions in the palisade and spongy mesophyll layers (Figure 2A). Cluster crystals of calcium oxalate have been reported as a feature of Malvaceae *s.l.* (Metcalfe & Chalk 1950).

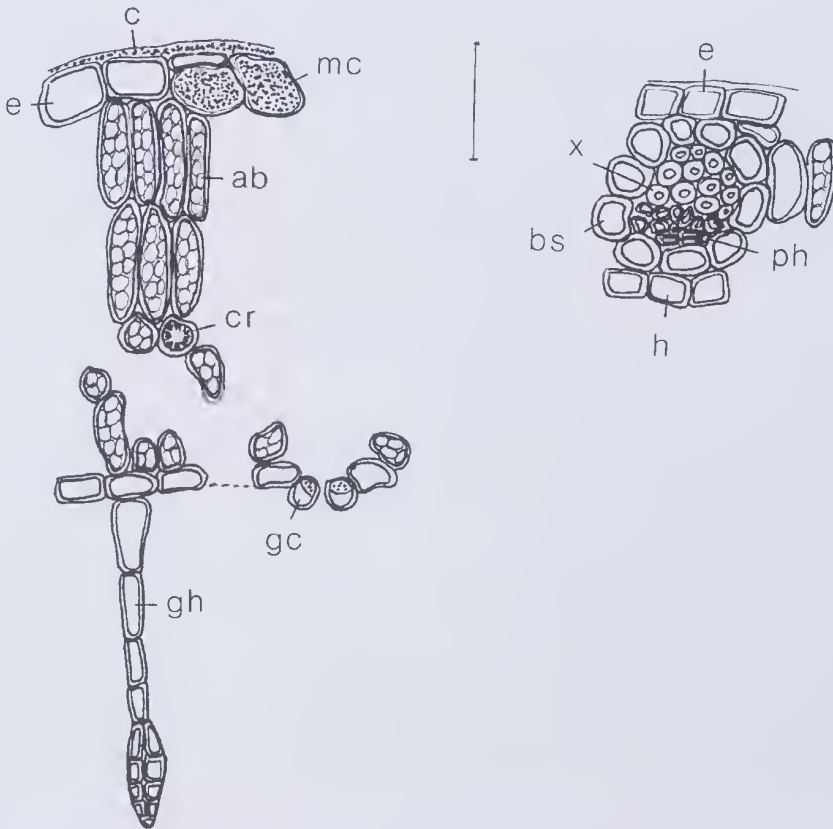


Figure 2. A – transverse section of leaf of *Lysiosepalum abollatum* (voucher C.F. Wilkins 1213). Key to labelling: ab abaxial palisade; c cuticle; cr crystal; e epidermis; gc guard cell; gh glandular hair; mc mucilage cell; scale bar = 0.1 mm. B – secondary vein of leaf of *Lysiosepalum hexandrum* (voucher K.A. Shepherd 68) bs bundle sheath; e epidermis; h hypodermis; ph phloem; x xylem.

Mucilage ducts are also present scattered in pith parenchyma cells of the stem and parenchyma cells in the centre of the anther connective. Transverse sections of *L. hexandrium* petals (voucher K.A. Shepherd 68) reveal three cell layers, being an upper and lower epidermis and a central layer of parenchyma. Two thirds of the cells in the central layer are large mucilage cells. Mucilage cells were, however, absent in the calyx and ovary. Tanniferous cells were not observed in any *Lysiosepalum* sections.

**Chromosome number.** Meiotic pollen mother cells of *L. involucratum* (voucher Kings Park Botanic Garden seed 196/1986, Magenta Rd, S of Newdegate) have a chromosome number of  $n = 10$  (Figure 3). This chromosome number is common in Malvaceae subfamily Byttnerioideae and agrees with four other counts reported for Lasiopetaleae:  $n = 10$  in *Keraudrenia exastia* C.F. Wilkins (Wilkins 1999),  $n = 10$  in *Hannafordia bissillii* subsp. *latifolia* (E. Pritz.) C.F. Wilkins and  $2n = 20$  in *H. quadrivalvis* F. Muell. subsp. *quadrivalvis* (Wilkins 2001 in press) and  $2n = 20$  in *Thomasia solanacea* (Sims) Gay (Federov 1969).

**Cladistic analysis.** The cladistic analysis resulted in one most parsimonious tree of 64 steps (Figure 4). A bootstrap analysis of 1000 replicates resulted in strong support for nodes one and four and moderate support for nodes two and three. Bremer support values showed the same pattern of support.

*Lysiosepalum* is a monophyletic genus, supported by three synapomorphies unique in Lasiopetaleae: unequal width calyx lobes (alternating broad and narrow); epicalyx completely enclosing mature buds (due to equally spaced epicalyx bracts rather than unilateral bracts); and calyx lobes that are scarcely fused at the base. Additional synapomorphies that support the *Lysiosepalum* clade are brittle ovary hairs (also found in *Guichenotia macrantha* and many *Thomasia*), epicalyx bracts that are fused at the base (also found in some *Lasiopetalum*), and glandular hairs on the pedicel which are also found in many species of *Guichenotia*, *Lasiopetalum*, *Keraudrenia* and *Thomasia*. The synapomorphy of glandular hairs on the pedicel is subsequently lost in *L. rugosum*.

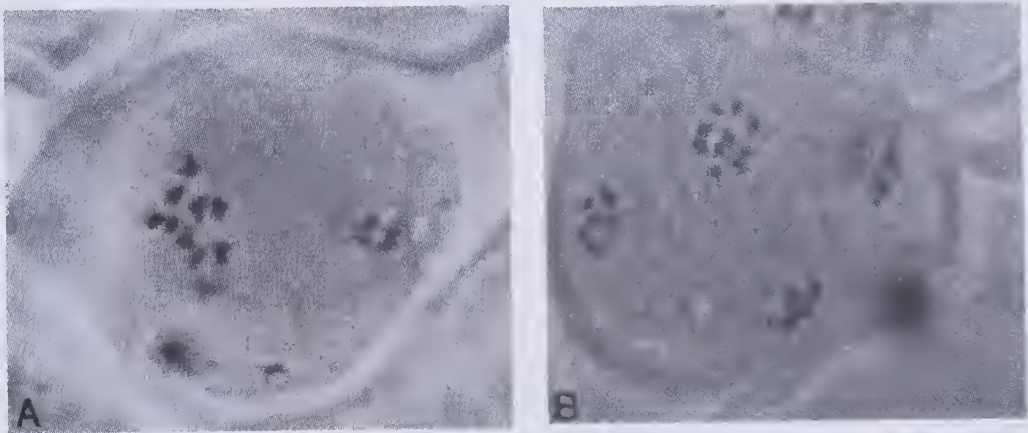


Figure 3. Pollen mother cells of *Lysiosepalum involucratum* with  $n = 10$ . A - showing meiotic, first metaphase. B - showing meiotic, second telophase.

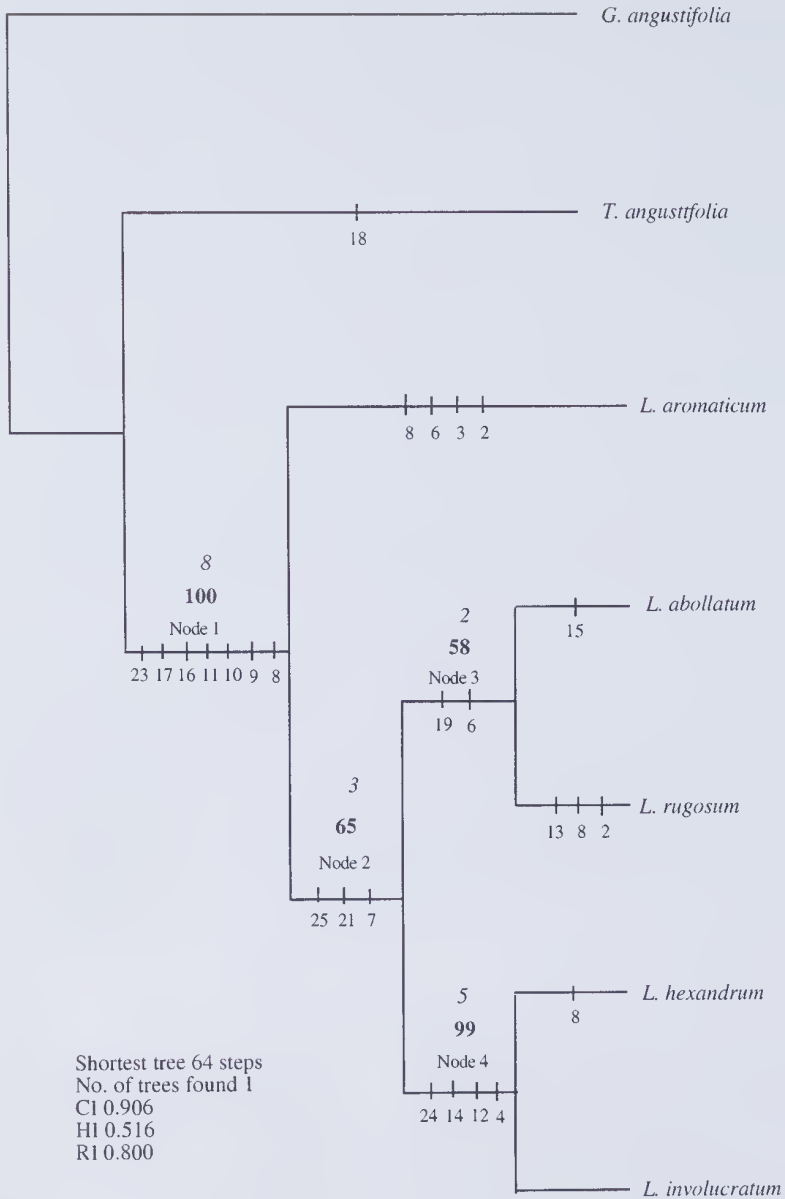


Figure 4. One tree found by a branch and bound search of five *Lysiosepalum* and two outgroup taxa. Numbers below the line are characters changing unambiguously on the branch. Numbers above the line in italics are Bremer support values and in bold are bootstrap frequencies to estimate stability of the nodes.

*Lysiosepalum aromaticum* is sister taxon to the remainder of the genus. It retains the plesiomorphic feature of a 5-partite calyx. Autapomorphies are long leaf petioles up to 7 mm long, consistently cordate leaf bases, broadly ovate to ovate leaf shape and long glandular hairs on the pedicels. The other four species are delimited at node two by flowers being 6-merous, broad filaments 0.4–0.5 mm wide, and more than eight ovules. *L. rugosum* and *L. abollatum* are sister taxa to the remaining two species *L. hexandrum* and *L. involucratum* and united at node three by having anthers that split longitudinally from the terminal pore at maturity rather than only poricidal dehiscence. They also have mature leaves



that are narrowly ovate rather than linear. *L. abollatum* is distinct from other *Lysiosepalum* in having stellate hairs on the abaxial surface of the epicalyx bracts that are less than 12-armed. At node four, sister taxa *L. hexandrum* and *L. involucreatum* are united by having leaves with strongly recurved margins rather than slightly recurved; adaxial and abaxial surfaces of epicalyx that are stellate tomentose rather than scattered to medium density; and brittle ovary hairs with long fused bases (> 50 % fusion), rather than short bases (< 50 % fusion). Long glandular hairs on the pedicels distinguish *L. hexandrum* from *L. involucreatum*.

### Taxonomy

***Lysiosepalum*** F. Muell. (Mueller 1859: 142–143). *Type: Lysiosepalum barryanum* F. Muell.

Multi-stemmed, compact *shrubs*, peppery scent present or absent, plant surfaces except petals and androecium with indumentum of stalked and/or sessile stellate hairs of mixed sizes, often mixed with short or long glandular hairs. *Young branches* terete, erect, tomentose, mature stems glabrescent. *Stipules* always present or variably present on a stem (*L. involucreatum*), persistent, sessile or stipitate, base oblique, juvenile blade broadly-ovate, mature form ovate or reniform, approximately one tenth of leaf length; leaf-like in having a coriaceous texture, margin slightly or strongly recurved and apex obtuse. *Leaves* alternate, simple, erect, spreading or reflexed, crowded on young growth. *Petioles* long or short. *Blades* grey-green or mid-green, broadly ovate, ovate, narrowly ovate, or linear-oblong, base cordate or attenuate, venation of juvenile leaves pinnipalmate and mature leaves pinnate; adaxial surface with reticulate minor venation and a deeply impressed midrib, either strongly rugose with crisped margin when major and minor veins strongly impressed, or faintly rugose with entire margin when only major veins strongly impressed; abaxial surface with prominent midrib. *Inflorescence* a leaf-opposed, elongate monochasial cyme of 2–8 bisexual flowers, rarely a branched cyme with up to 12 flowers, the peduncle and inflorescence stem always persistent from previous flowering season; peduncle red. *Bracts* none subtending terminal flower, one subtending intermediate flowers and two subtending apical flower, persistent, spatulate or linear, apex acute. *Pedicels* red, often marginally wider at apex. *Epicalyx bracts* three, directly below calyx, persistent, broadly ovate to ovate, equally spaced to completely enclose the mature bud, fused at base 0.3–1 mm, recurved from flowers, partially re-enclosing fruiting calyx. *Flowers* facing downwards, 6-merous except *L. aromaticum* which is 4- or 5-merous. *Calyx* persistent, rotate, with a very short tube and alternating wide flat lobes and narrower lobes that are either flat or with reflexed margins; lobes petaloid, mauvish-pink, narrowly ovate, narrowly elliptic or oblong, the adaxial surface with raised thickened base and impressed veins extending from thickened base to apex and dense indumentum of fine white 2–5-armed stellate hairs to 0.1 mm diam. and simple hairs, the abaxial surface with thickened base and 3–5 prominent ribs extending into the lobe from thickened base. *Petals* absent or present, scale-like, sessile, free, erect or horizontal, dark red or bright red, obovate or obcordate. *Androecium* dark red or bright red; staminodes absent or 3–6, on apex of staminal tube or free, minute, triangular; stamens antepetalous. *Filaments* free or shortly fused into a staminal tube; free portion flattened, broad or narrow. *Anthers* in one whorl, laterally touching at incurved apex to form a tube, with narrow gaps between anther bases, ventrifixed with apex of filament fused to anther surface (ventriadnate), 2-celled, narrowly ovate, with introrse dehiscence from narrowly ovate, subterminal pores, which (in two species) become extended as longitudinal slits at maturity. *Pollen* tricolporate, white, somewhat flattened, elliptic in outline, exine reticulate (Figure 5). *Carpels* laterally connate; ovary sessile, ovoid, 3-locular, placentation axile, outer surface with a dense covering of sessile, brittle, white, stellate hairs with cell bases fused to form a short to long oblong base, inner surface of locules mainly glabrous or rarely with white, minute, simple hairs or few-celled, stellate hairs. *Ovules* erect, 4–12 per loculus. *Style* simple, filiform, glabrous or with sessile white stellate hairs on the basal quarter. *Stigma* dry, tubular. *Fruit* a loculicidally

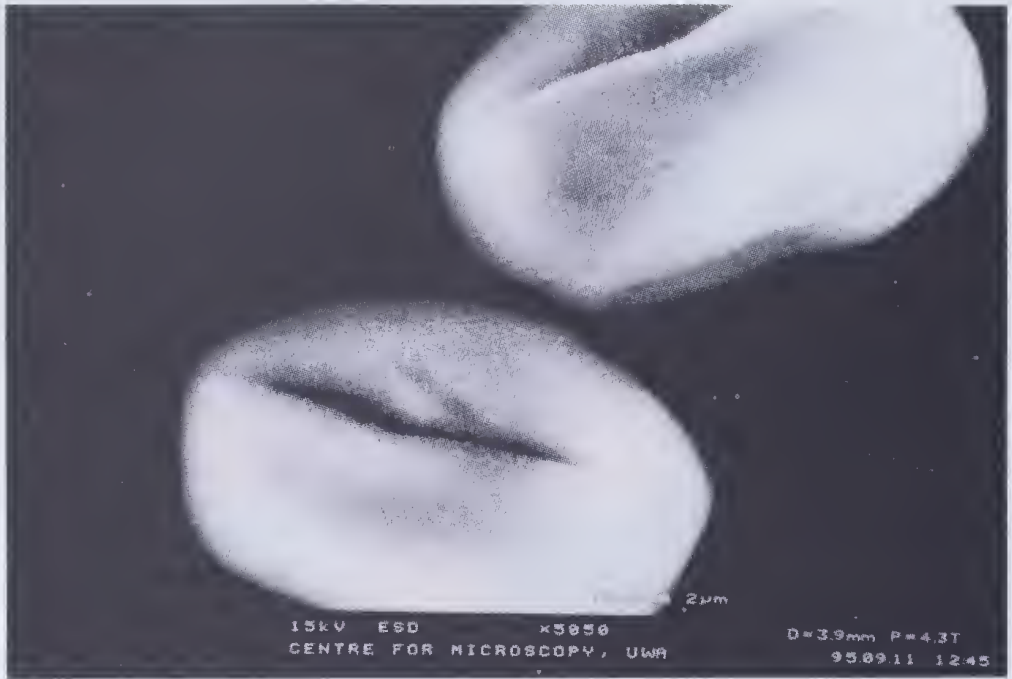


Figure 5. Reticulate exotesta of white, prolate pollen of *Lysiosepalum involucreatum* (voucher *L. involucreatum*, Kings Park Botanic Garden seed 196/1986, Magenta Rd, S of Newdegate).

dehiscent capsule, outer surface with persistent, brittle, stellate hairs. *Seed* dark brown, ellipsoid, smooth with scattered, simple and sessile stellate hairs, aril cream, cap-like, with two longer lobes extending up the hilar surface to half the seed length, testa bitegmic, endosperm present. *Embryo* straight.

*Distribution.* *Lysiosepalum* is widespread in the wheatbelt from Yuna (north-east of Geraldton) to Ravensthorpe (Figure 6). Plants occur in open woodland or shrubland, often at tree bases, in lateritic gravel, yellow-brown sand, sandy clay or sandy loam.

*Notes.* Chapman (1991) observed that Bentham (1863) misspelt the name *Lysiosepalum* as *Lyriosepalum* in the index to "Flora Australiensis", but had the correct spelling in the text, and Schumann misspelt the name as *Lysiopetalum* (Schumann 1895).

*Lysiosepalum* is most similar to Lasiopetaleae genera *Thomasia* Gay, *Lasiopetalum* Sm. and *Guichenotia* Gay in having terminal, poricidal anther dehiscence rather than dehiscence by extrorse slits as in the three remaining genera of the tribe, *Hannafordia* F. Muell., *Keraudrenia* Gay and *Seringia* Gay. *Lysiosepalum* is, however, unique in Lasiopetaleae in having features that Mueller (1859) considered distinctive when he described the genus. One of these is three epicalyx bracts that are shortly fused at the base and equally spaced to completely enclose the mature bud. Other Lasiopetaleae have one epicalyx bract (*Lasiopetalum*), no epicalyx (*Keraudrenia* and *Seringia*), or three unilateral epicalyx bracts (*Guichenotia*, *Hannafordia*, *Lasiopetalum*, *Thomasia*) that if ovate rather than filiform, cover only the exposed side of the bud rather than completely enclosing the mature bud. The second distinctive feature of the genus is the almost free calyx lobes, compared with other Lasiopetaleae which have longer calyx tubes. Mueller (1859) also described *Lysiosepalum* anthers as being distinct from those of *Lasiopetalum* in not splitting longitudinally from the terminal pores, however, mature anthers of *L. rugosum* and the new species *L. abollatum* do share this character.

**Key for species of *Lysiosepalum***

1. Leaves with a peppery scent; blade ovate to broadly ovate, petiole 4–7 mm long. Flowers (4)5-merous, anthers bright red. (Narrogin area) ..... **2. *L. aromaticum***
1. Leaves not scented; blade narrowly ovate to linear-oblong, petiole 0.5–3 mm long. Flowers 6-merous, anthers dark red
  2. Pedicel and abaxial surface of epicalyx bracts with red and/or green, conspicuous, long-stalked, clavate glands *c.* 0.7 mm long, longer than or same length as stellate hairs. (S of Wongan Hills to E of Katanning) ..... **3. *L. hexandrum***
  2. Pedicel and abaxial surface of epicalyx bracts either without glands or with inconspicuous white glands *c.* 0.1 mm long, shorter than stellate hairs
    3. Adaxial surface of mature leaf smooth or slightly rugose, margin entire or slightly irregular, strongly recurved. Adaxial surface of epicalyx bract with dense, white tomentum of stellate hairs; abaxial surface orange-tan. (Chiddarcooping to Pallinup River, S of Gnowangerup) .... **4. *L. involucreatum***
    3. Adaxial surface of mature leaf strongly rugose, margin crisped, moderately recurved. Adaxial surface of epicalyx bract with scattered to medium density, white, stellate hairs; abaxial surface greenish tan, or white with brown-tan spots, rarely all tan
      4. Petiole of mature leaves 1–3 mm long. Young branches and inflorescences with a close tomentum of short, sessile or subsessile, *c.* 24-armed stellate hairs to 0.3 mm diam, glands absent. Epicalyx bracts acute. (NE of Geraldton to E of Wongan Hills) ..... **5. *L. rugosum***
      4. Petiole of mature leaves 0.5–1 mm long. Young branches and inflorescences with woolly appearance from scattered to medium density, long-stalked, 4–12-armed, stellate hairs 1–3 mm diam., often over short clavate glands. Epicalyx bracts acuminate. (Wongan Hills) ..... **1. *L. abollatum***

**1. *Lysiosepalum abollatum* C.F. Wilkins, *sp. nov.***

Species insignis indumento laxo cum pilis magnis (usque ad 3 mm diameter) stellatis ornatis, 4–12 brachiis per pilum; pilis supra pedicellum, pedunculum, et bracteolum exteriorem praecipue grandioribus. Bracteolus abaxialis ad apicem purpureo-ruber ad basim viridis perspicue manifestus.

*Typus:* Wongan Hills [precise locality withheld], Western Australia, 1 October 1996, C.F. Wilkins, CW 1213 & J. Wege, (*holo:* PERTH (04896491), *iso:* CANB, K, MEL, NSW).

*Shrub* to 1.5 x 1.5 m, scent absent; young growth and inflorescences (young branches, stipules, petioles, bracts, peduncles and pedicels) with white woolly appearance from large stellate hairs; indumentum of scattered 4–12-armed stellate hairs 1–2.3 mm diam., with a red stalk 0.2–0.6 mm long and arms white with tan-centre, overlying sessile or subsessile, stellate hairs 0.25–1.0 mm diam. and white clavate glands *c.* 0.1 mm long. *Stipules* usually present, sessile, 0.6–1.5 x 0.6–1.3 mm (*c.* 4 x 1.5 mm in young growth). *Leaves* erect or spreading; petiole 0.5–1 mm long; blade mid green, discolorous, narrowly ovate, 10–16 x 2–3 mm (*c.* 35 x 4 mm in young growth), base sub-cordate, apex obtuse, margin crisped and moderately recurved, both surfaces with stalked stellate hairs and white clavate glands but no underlying sessile hairs; abaxial surface with a dense indumentum; adaxial surface strongly rugose, with scattered hairs. *Inflorescence* 40–90 mm long, 4- or 5(8)-flowered; peduncle 10–35 mm long. *Bracts* linear-oblong or spatulate, 5–10 x 0.3–1 mm, margins fringed with

stalked stellate hairs. *Pedicels* 5–12 mm long. *Epicalyx bracts* shortly fused at base to 0.3 mm, ovate, 6.5–9 x 3–6.5 mm, apex acuminate, margins fringed with stalked, stellate hairs; adaxial surface red, with scattered sessile, fine, white, stellate and simple hairs and clavate glands c. 0.1 mm long; abaxial surface green base and purple apex with medium density, long-stalked stellate hairs to 3 mm diam., which protrude from the margins, overlying white clavate glands c. 0.1 mm long. *Flowers* 6-merous. *Calyx lobes* ovate, elliptic or oblong, 6.5–11.5 x 3.2–3.5 mm, apex acute; abaxial surface with sessile and stalked, white stellate hairs c. 0.4 mm diam. and scattered short, clavate glands c. 0.1 mm long, ribs with additional scattered, stalked, white tan-centred, stellate hairs to 1 mm diam. *Petals* usually present, usually horizontal, rarely erect, flat, dark red, 0.8–1.5 x 0.8–1.3 mm. *Androecium* dark red; staminodes absent. *Filaments* free or shortly fused into staminal tube 0.2–0.4 mm long; free portion

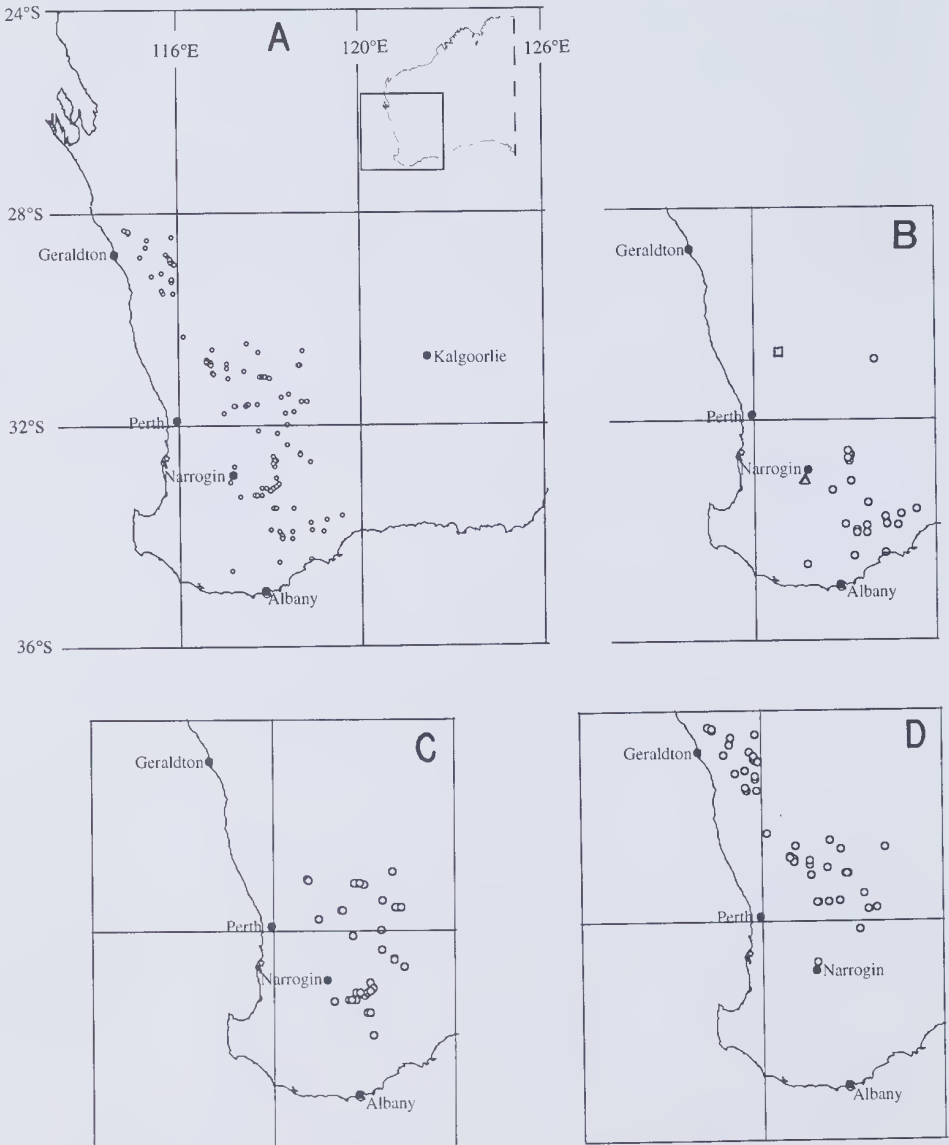


Figure 6. Distribution of *Lysiosepalum* in Western Australia. A – whole genus. B – *L. abollatum* □, *L. aromaticum* △ and *L. involucreatum* ○. C – *L. hexandrum*. D – *L. rugosum*.



0.5–0.7 x 0.6 mm. Anthers 3–4.8 x 0.8–1 mm; pores becoming extended as longitudinal slits when mature. Ovary with arms of the stellate hairs shortly fused at base. Style 2.5–3.7 mm long, extending c. 3 mm beyond anthers; base with a dense indumentum of sessile, white, stellate hairs. Fruit not observed. (Figure 7)

*Selected specimens examined.* WESTERN AUSTRALIA [precise locality withheld]: Wongan Hills, 27 Aug. 1976, R. Coveny 7851 & B.R. Maslin (PERTH); Wongan Hills, 11 Sep. 1993, M.J. Fitzgerald

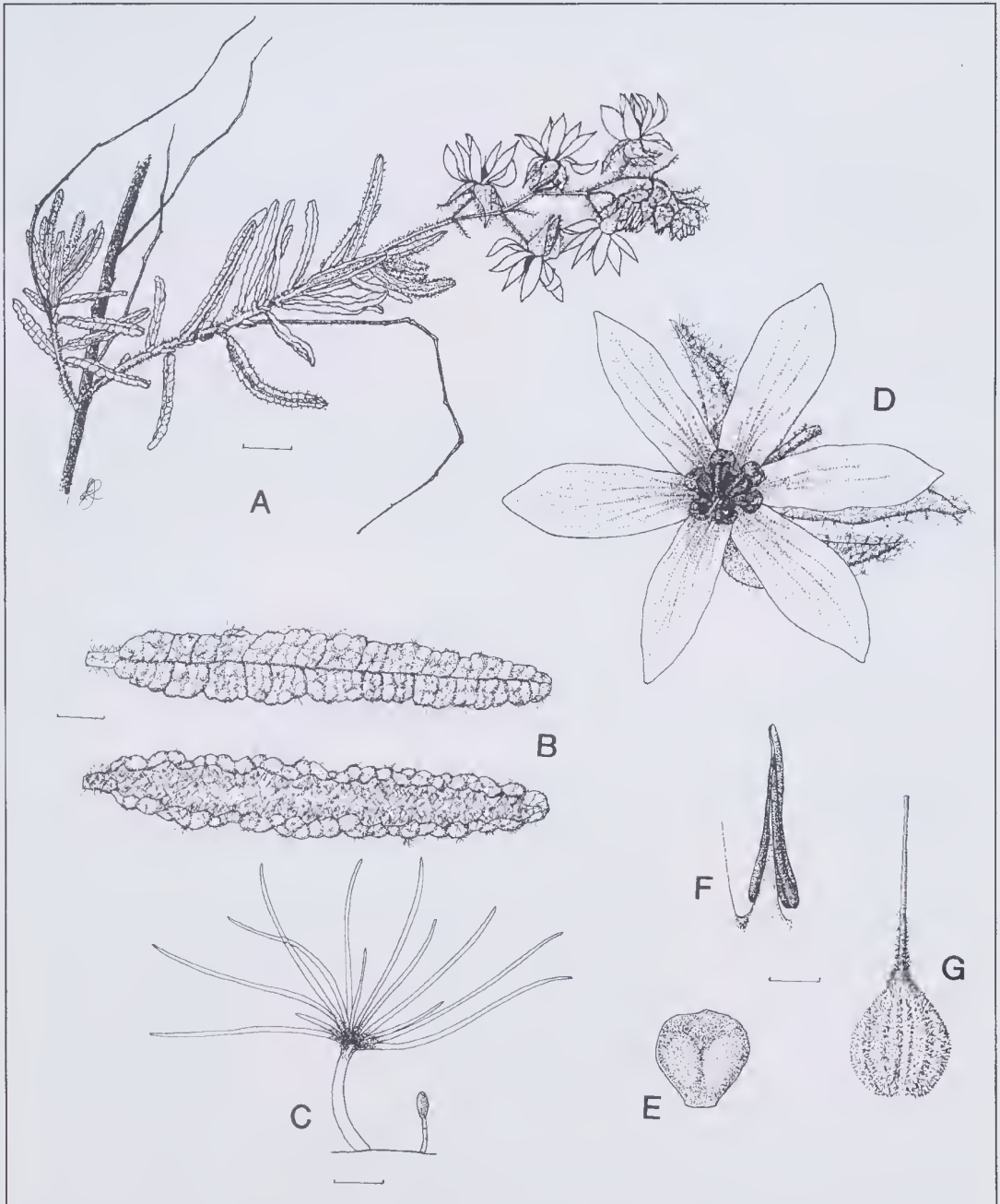


Figure 7. *Lysiosepalum abollatum*. A – habit (bar = 1 cm). B – leaf surfaces (bar = 2.5 mm). C – stellate hair and gland on abaxial surface of bracteole (bar = 0.5 mm). D – flower (bar = 2.5 mm). E – petal. F – anther adaxial view. G – pistil (E, F & G bar = 1 mm). Drawn from K.F. Kenneally 9337.

0001 (PERTH); Wongan Hills, 15 Sep. 1983, *K.F. Kenneally* 8830 (PERTH); Wongan Hills, 3 Sep. 1984, *K.F. Kenneally* 9337 (PERTH).

*Distribution.* Restricted to one locality in the Wongan Hills range of hills, north of the township of Wongan Hills, Western Australia. (Figure 6B)

*Habitat.* This species occurs in orange-brown, sandy clay with laterite, in open mallee woodland (to c. 5 m) at base of *Eucalyptus* trees.

*Phenology.* Flowering time is August to October. Fruit not observed.

*Conservation status.* CALM Conservation Codes for Western Australian Flora: Priority One. There have been four collections in the same approximate area, however, it is not known if they are from the same population. Currently known by the authors from one or two small populations on a private reserve, bordered by cleared farmland. Further survey urgently required with probable need for recognition as Declared Rare Flora.

*Etymology.* *Abolla* (Latin) translates as "a robe of thick woollen stuff worn by soldiers and philosophers", and alludes in this species to its woolly appearance derived from the loose covering of long-stalked, large, stellate hairs.

*Affinities.* This species is similar to *L. rugosum* in having a long inflorescence with up to eight flowers and leaves with rugose surfaces and recurved margins. It differs in having short petioles 0.5–1 mm long, rather than 1–3 mm long, epicalyx bracts with an acuminate rather than acute apex and a woolly appearance from long-stalked, large, stellate hairs rather than a close tomentum of sessile, small, stellate hairs.

## 2. *Lysiosepalum aromaticum* C.F. Wilkins, *sp. nov.*

Species fortiter amaro odora, foliis late ovatis vel ovatis petiolis longis, stipulis petiolatis, floribus 4 vel 5 meris, antheris rutilis a congeneribus diversa.

*Typus:* State Forest 52, Highbury block, Eastern Boundary, Western Australia, 23 November 1998, *G. Warren* 23, *C. Taylor*, *P. Rose*. (*holo:* PERTH 05315700; *iso:* K).

*Shrub* to 75 x 100 cm with strong aromatic scent; all plant surfaces except adaxial epicalyx bract surface, calyx, androecium and gynoecium with dense, multicelled, long-stalked, red-tipped clavate glands to 0.7 mm long, overlying dense, sessile, 10–12-armed, white stellate hairs to 0.5 mm diam.; young growth with tau hairs. *Stipules* always present, stipitate, 0.5–1 mm long, blade 2–6 x 2–7 mm (seedling young growth blade c. 10 x 13 mm, petiole c. 4 mm long). *Leaves* reflexed. *Petioles* 4–7 mm long (c. 15 mm in seedling young growth). *Blades* grey-green, scarcely discoloured, ovate to broadly ovate, 16–22 x 10–12 mm (seedling young growth c. 50 x 30 mm); blade strongly rugose, base cordate apex acute or rounded, margin crisped and slightly recurved. *Inflorescence* 25–50 mm long, 2–4(5)-flowered; peduncle 9–20 mm long. *Bracts* spatulate, 3–7.5 x 0.8–1.3 mm; adaxial surface with medium density clavate glands; abaxial surface with dense stellate hairs and glands. *Pedicels* 5–6 mm long. *Epicalyx bracts* very shortly fused at base for 0.3–0.5 mm, broadly ovate, 6.5–8.5 x 4.5–6.5 mm, apex acute; adaxial surface with medium density, sessile, white, fine stellate hairs c. 0.2 mm diam. and simple hairs. *Flowers* 4- or 5-merous. *Calyx* lobes elliptic, 5.8–6.5 x 2–3.5 mm, apex acute; abaxial surface ribs and blade with scattered, sessile, white, 2–5-celled stellate hairs to 0.5 mm diam. *Petals*

always present, erect, flat, bright red, *c.* 1 x 0.8 mm. *Androecium* bright red; staminodes *c.* 0.6 x 0.2 mm. *Filaments* free, *c.* 0.2 x 0.2 mm. *Anthers* 3–4 x 1.3 mm; pores not becoming extended at maturity. *Ovary* with cells of the stellate hairs shortly fused at base. *Style* short, *c.* 1.6 mm long, stigma level with apex of anthers; style base with scattered, sessile, white, stellate hairs. *Fruit* ovoid, *c.* 5.5 x 5.5 mm. *Seed* *c.* 2.3 x 1.3 mm. (Figure 8)

*Other specimens examined.* WESTERN AUSTRALIA: State Forest 52, Highbury block, Eastern Boundary track off Forestry Rd, S of Narrogin, C.F. & J. Wilkins 1418, G. Warren, C. Taylor, P. Rose, 23 May 1999 (PERTH).

*Distribution.* Restricted to one population south of Narrogin, Western Australia. (Figure 6B)

*Habitat.* This population occurs in orange-brown sandy loam at the base and mid slope of a granite rock outcrop. It is mainly an understorey shrub in *Allocasuarina huegellii* woodland with scattered *Eucalyptus calophylla*, *Astroloma drummondii*, *Patersonia* and *Stypandra glauca*, however, there are ungrazed *L. aromaticum* plants, in open conditions in an adjacent, grazed paddock.

*Phenology.* Flowering time is October to November.

*Conservation status.* CALM Conservation Codes for Western Australian Flora: Priority Two. Known from a single population of *c.* 200 plants in a state forest. Further survey is urgently required as this taxon probably needs to be categorized as Declared Rare Flora.

*Etymology.* The specific epithet is taken from the Latin – *aromaticus* meaning aromatic, for the shrub's spicy odour.

*Affinities.* This species is similar to *L. hexandrum* in having long-stalked, red, clavate glands on inflorescences, however, *L. aromaticum* also has abundant glands on stems and leaves. It resembles *L. abollatum* and *L. rugosum* in having strongly rugose leaves, however, this species is distinct in the genus by having broadly ovate to ovate, rather than narrowly ovate to linear, leaves, flowers that are (4)5-merous, rather than consistently 6-merous, and bright red, rather than dark red, anthers.

**3. *Lysiosepalum hexandrum*** (S. Moore) S. Moore (in Sargent 1923: 287). – *Thomasia hexandra* S. Moore (Moore 1921: 245–246). *Type citation:* Emu Hill (about 50 miles east of Beverley), by State School; Hb. Sargent 782. *Type:* Emu Hill, about 50 miles [80 km] east of Beverley, Western Australia, O.H. Sargent 782 (*holo:* BM).

*Shrub* to 90 x 90 cm, scent absent; young branches with a tomentum of *c.* 24-armed, tan or white with tan-centred stellate hairs 0.2–0.4 mm diam., mainly mixed with scattered, stalked, red clavate glands *c.* 0.3 mm long. *Stipules* always present, sessile, 0.5–1 x 1–4 mm. *Leaves* erect. *Petioles* 0.6–1.5 mm long. *Blades* grey-green, discolorous, linear-oblong or narrowly elliptic, 3–17 x 1.3–2 mm, base attenuate, apex obtuse, margin either slightly irregular or entire, strongly recurved; adaxial surface faintly rugose or smooth, with medium density, sessile, fine, white stellate hairs *c.* 0.4 mm diam., often with scattered short-stalked clavate glands *c.* 0.1 mm long; abaxial surface usually with only midrib showing, with dense tan, stellate hairs, often with scattered glands *c.* 0.1 mm long. *Inflorescence* 35–70 mm long, (3)5(8)-flowered; peduncle 10–30 mm long, with long-stalked, red clavate glands to 0.7 mm long, overlying medium density, sessile, white stellate hairs *c.* 0.4 mm diam. *Bracts* spatulate, 2–7 x 0.5–1.3 mm, both surfaces with medium to dense stellate hairs and scattered glands to 0.5 mm long. *Pedicels* 4–7.5 mm long, with the same indumentum as the peduncle.

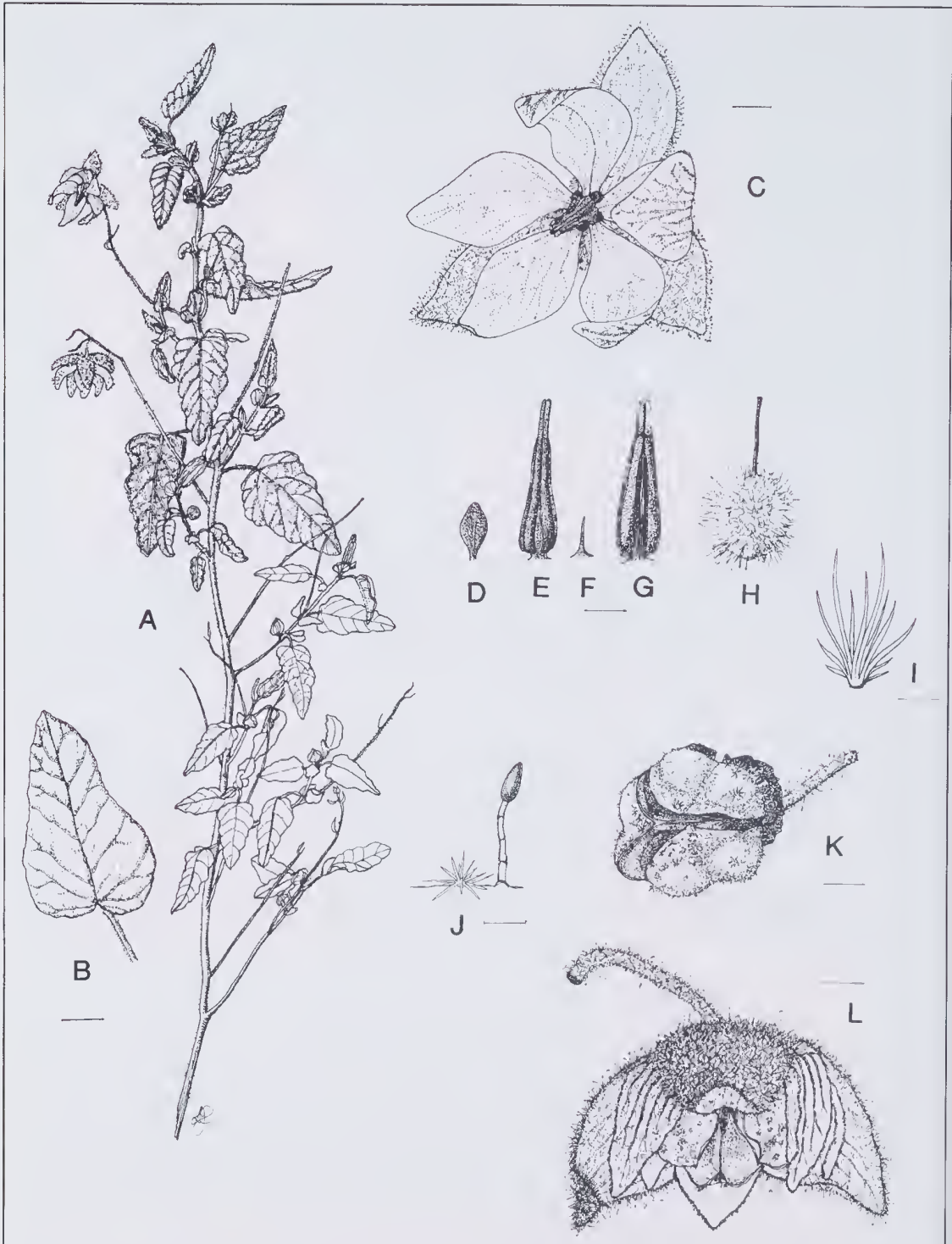


Figure 8. *Lysiosepalum aromaticum*. A - habit, B - juvenile leaf (bar = 1 cm). C - flower (bar = 2.5 mm). D - petal. E - anther abaxial view, F - staminode, G - anther adaxial view, H - pistil (D-H bar = 1 mm). I - ovary hair (bar = 0.05 mm). J - glandular hair and stellate hair on abaxial surface of bracteole (bar = 0.2 mm). K - fruit with sepals removed. L - fruit within sepals and bracteoles (K & L bar = 8 mm). Drawn from G. Warren 23 (A-J) and C.F. Wilkins 1418 (K,L).



*Epicalyx bracts* shortly fused at base to 0.5 mm, ovate, 5.5–10 x 3–6 mm, apex acute; adaxial surface white, with medium to dense stellate hairs and scattered glands c. 0.1 mm long; abaxial surface greenish-tan when mature, with dense long-stalked, red and/or green, clavate glands 0.5–0.7 mm long, overlying white with tan-centred or yellow stellate hairs to 0.6 mm diam. *Flowers* 6-merous. *Calyx lobes* narrowly elliptic, narrowly ovate or narrowly obovate, 6–8.5 x 2–4.5 mm, apex rounded; abaxial surface with scattered stellate hairs to 0.3 mm diam., ribs with dense, white stellate hairs, c. 0.5 mm diam. and occasional long red glands. *Petals* usually absent, when present alignment and curvature unknown, dark red, c. 1.5 x 0.8 mm. *Androecium* dark red; staminodes absent or minute, narrowly triangular, c. 0.1 mm long. *Filaments* free or shortly fused into staminal tube 0.3–1.4 mm long; free portion 0.3–1.4 mm x 0.8 mm. *Anthers* 2.8–4 x 0.8–1 mm; pores not becoming extended at maturity. *Ovary* with cells of the stellate hairs fused for up to half of hair length. *Style* 2–2.8 mm long, extending c. 1 mm beyond anthers; base with few to medium density, stellate hairs. *Fruit* 3–5 x 2.5–4 mm. *Seed* 1.8–2 x c. 1 mm. (Figure 9)

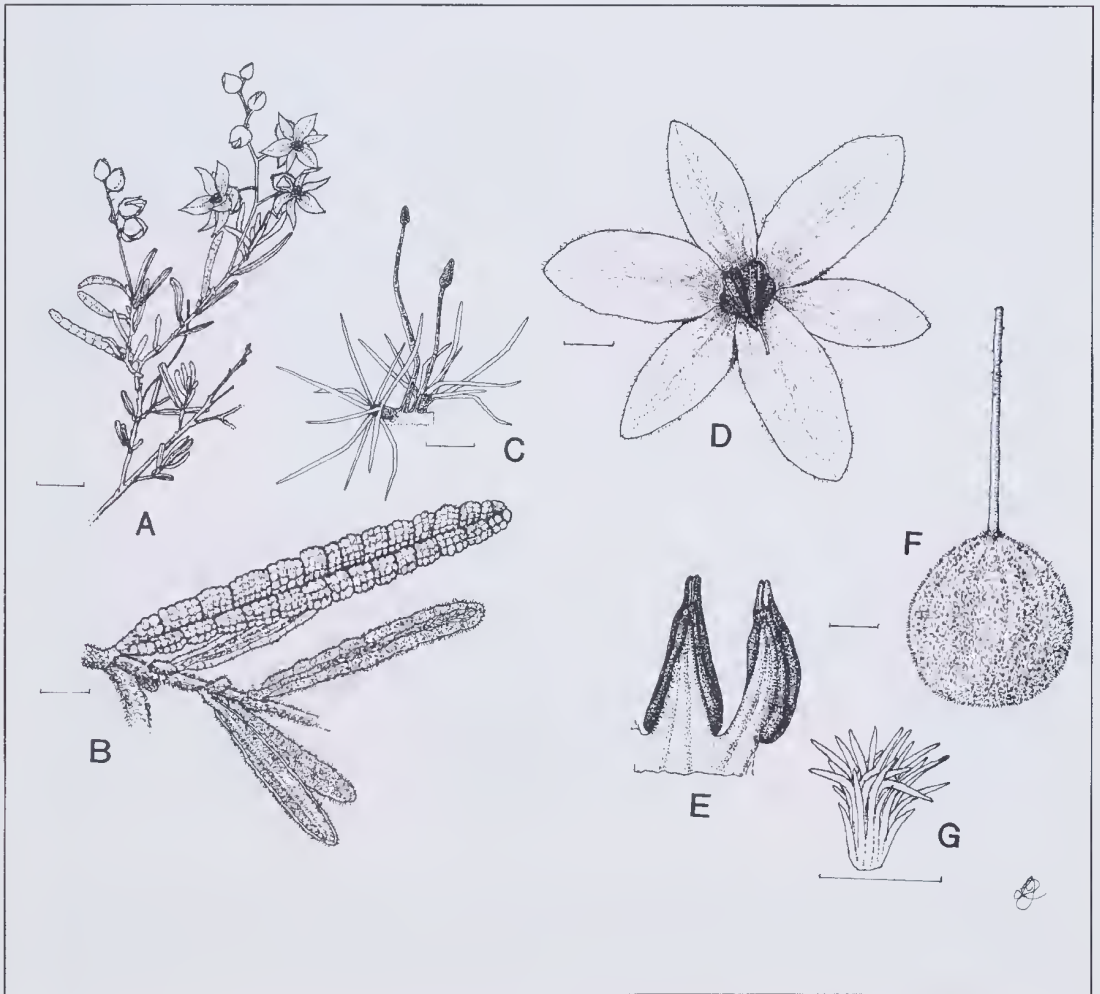


Figure 9. *Lysiosepalum hexandrum*. A – habit (scale bar = 1 cm). B – juvenile leaf with rugose surface and mature leaves with smooth surfaces. C – glandular and stellate hairs on abaxial surface of bracteole (bar = 0.1 mm). D – flower (B & D bar = 2 mm). E – adaxial surface of androecium. F – pistil (E & F bar = 0.5 mm). G – ovary hair (bar = 0.1 mm). Drawn from K. Shepherd 68 and C.F. Wilkins 167.

*Selected specimens examined.* WESTERN AUSTRALIA: 115 mile peg on Great Eastern Hwy, 13 Sep. 1962, *T.E.H. Aplin* 1986 (AD); S of Narembeen, 8 Aug. 1963, *A.M. Ashby* 162 (AD); 2 km by road E of Pederah, 17 Oct. 1977, *W.H. Barker* 2467 (AD); 5.5 km E of Tammin, 11 Sep. 1976, *R. Coveny* 8318 & *B. Habersley* (PERTH); 26 km due SW of Bodallin, 16 Sep. 1982, *R.J. Cranfield* 2349 (PERTH); Holden Rd, Shire of Lake Grace, 24 Oct. 1986, *E.J. Croxford* 5346 (PERTH); 6 km W of Burracoppin, 23 Aug. 1995, *R. Davies* 85 (PERTH); Kukerin, Oct. 1913, *M. Koch* 2185 (NSW, MEL, PERTH); 25 km NE of Dumbleyung, 20 Sep. 1964, *R.H. Kuchel* 2007 (AD); Tammin, Sep.–Nov. 1909, *J.H. Maiden s.n.* (NSW); 4 miles [6 km] W of Nyabing, 14 Sep. 1961, *R.D. Royce* 6704, (PERTH); 9.8 km E of Bending on Reserve Rd, 8 Sep. 1994, *K.A. Shepherd* KS 57, *J.A. Chappill*, *J.A. Wege* (PERTH, UWA); 500 m N of Jilikin Flat Rd on Bueffner Rd, 11 Oct. 1996, *J.A. Weges s.n.* (PERTH, UWA); 50 km NNW of Merredin, 31 Oct. 1974, *D.J.E. Whibley* 4746 (AD, PERTH); Konongorring new school site, Williams–Wongan Hills road, 5 Sep. 1992, *C.F. Wilkins* CW 167–168 (PERTH, UWA); Boolanelling Nature Reserve, Pannell Williams Rd, 9.5 km N of Quairading–Bilbarrin road, 25 Nov. 1994, *C.F. Wilkins* CW 736 (PERTH, UWA); Tarin Rock, 9 Nov. 1968, *J.W. Wrigley s.n.* (MEL).

*Distribution.* This species ranges from Konongorring to Nyabing, in the south-west of Western Australia. (Figure 6C)

*Habitat.* This species is found as understorey in *Eucalyptus* open woodland, or rarely heath, in yellow or brown clayey sand, usually with laterite.

*Phenology.* Flowering time is August to October. Fruiting October to December.

*Conservation status.* This species is well collected and mainly recorded as abundant in the area of collection. No special status is required.

*Etymology.* Named due to the hexandrous flowers.

*Affinities.* This species has the distinct specific features described by Moore of long red glandular hairs on the epicalyx, epicalyx that are greenish rather than orange-tan in colour and mainly narrower than in *L. involucreatum*, and petals that are usually absent and if present then fewer than six per flower whereas *L. involucreatum* usually has six petals. Similarities to *L. involucreatum* are leaves with smooth or slightly rugose surfaces and strongly recurved leaf margins.

*Notes.* Two specimens from Chiddarcooping and Narembeen are anomalous as the long red glands are rare or absent rather than forming a dense covering as in other specimens examined. These have been determined as *L. hexandrum* as they are apetalous, with greenish-tan abaxial epicalyx bract surfaces rather than tan and without the dense, white tomentum found on the epicalyx bract adaxial surface of *L. involucreatum*.

**4. *Lysiosepalum involucreatum* (Turcz.) Druce (Druce 1917: 634). – *Thomasia involucreata* Turcz. (Turczaninov 1852: 143). *Type citation:* N. Holl. Drum. V. n. 255. *Type:* south-west of Western Australia, *Drummond coll.* 5, n. 255 (*holo:* KW n.v. photograph PERTH 05070341; *iso:* BM, K, MEL 724048, PERTH 01625608, W).**

*Lysiosepalum barryanum* Muell. (Mueller 1859: 143). *Type citation:* In planitiebus ad flumen Phillips Mx. *Type:* Phillips River, Western Australia, *Maxwell (holo:* MEL 724049)

*Illustration.* Grieve (1998: 653).

*Shrub* to 1.2 m x 1.2 m, scent absent; young branches with close tomentum of sessile or short-stalked, up to 24-celled, white with brown-centred, stellate hairs 0.2–0.6 mm diam., glands absent. *Stipules* present at most leaf nodes of each stem but absent at others, sessile, 0.6–1.3 x 0.5–1.3 mm (4.5 x 2.5 mm on young growth). *Leaves* erect. *Petioles* 0.5–1.0 mm long. *Blades* grey-green, discolorous, linear-oblong, 8–15 (20) x 1–2 mm (30–45 x 5–10 mm on young growth), base attenuate, apex obtuse, margin entire, strongly recurved; adaxial surface smooth or faintly rugose with a velvety appearance from dense, sessile, white with pale tan centred, stellate hairs 0.2–0.7 mm diam., occasionally with concealed clavate glands to 0.1 mm long; abaxial surface usually only the midrib showing, with dense sessile and scattered red-stalked stellate hairs. *Inflorescence* 35–50 mm long, 2 or 3(4)-flowered; peduncle 12–20 mm long, with a medium density indumentum of stellate hairs to 1.0 mm diam. with red-stalk to 0.7 mm long and white with brown-centre, overlying smaller, sessile, white stellate hairs. *Bracts* linear, narrowly ovate or narrowly obovate, 2.5–6.5 x 0.3–1.5 mm; adaxial surface with glands c. 0.1 mm long and sessile white stellate hairs; abaxial surface and margin with dense stalked stellate hairs. *Pedicels* 5–7 mm long, with a similar diameter and indumentum to peduncle. *Flowers* 6-merous. *Epicalyx bracts* fused at the base to 1 mm, broadly ovate, 5–9 x 3–7 mm, apex acute; adaxial surface with a dense indumentum of short-stalked and sessile, white, fine, stellate hairs and concealed clavate glands c. 0.1 mm long; abaxial surface concealed by a tomentum of long red-stalked, orange-tan stellate hairs to 1.5 mm diam., which protrude from the margins, overlying short glands 0.1 mm long and white stellate hairs to 0.3 mm diam. *Calyx lobes* narrowly ovate, 6.5–10 x 2.5–5 mm, apex rounded; abaxial surface with scattered, sessile, white stellate hairs to 0.2 mm diam. and ribs with additional scattered stalked, white with tan-centred, stellate hairs to 0.5 mm diam. and rarely short clavate glands on ribs and lamina. *Petals* rarely absent, erect, dark red, cup-shaped, 1.2–2.1 x 1–1.4 mm. *Androecium* dark red; staminodes 3–6 per flower, narrowly triangular, c. 0.1–1.6 mm long. *Filaments* free or shortly fused into staminal tube 0.5–1 mm long; free portion c. 0.5 x 0.6 mm or absent. *Anthers* 3.3–4.5 x 0.8–1 mm; pores not becoming extended at maturity. *Ovary* with cells of the stellate hairs fused for up to 3/4 of hair length. *Style* 2.5–4 mm long, extending up to 4 mm beyond anthers; base with dense stellate hairs. *Fruit* c. 5 x 4.5 mm. *Seeds* 1.2–1.8 x 0.8–1 mm. (Figure 10)

*Selected specimens examined.* WESTERN AUSTRALIA: Kulin, Sep. 1947, A. Ashby 118 (AD, PERTH); Jerramungup, 18 Oct. 1964, J.S. Beard 3641 (PERTH); 6 km NE of S Kulin, 25 Oct. 1983, R.J. Cranfield 4758 (PERTH); Kukerin–Tarin Rock road, 26 Oct. 1981, E.J. Croxford 1608 (PERTH); Pingrup road, 18 Oct. 1982, E.J. Croxford 2010 (PERTH); Cowcowing, Oct. 1904, M. Koch 1180 p.p., (P, PERTH); near Ongerup, 24 Oct. 1972, E.C. Nelson ANU 16797, (CANB); 9 km WNW of Bivouac Rock, Fitzgerald River National Park, 4 Nov. 1973, K. Newbey 3965 (PERTH); Millers Point above Beaufort Inlet, Pallinup River Mouth, 17 Nov. 1992, C.J. Robinson 1034 (PERTH); Gnowangerup, 22 Oct. 1920, O.H. Sargent 862 (PERTH); 6 km S of Toompup homestead, 7 Oct. 1979, Toelken 6471, (AD, PERTH); head of Fitzgerald River, 65 miles [.. km] W of Ravensthorpe, 3 Sep. 1947, J.H. Willis (MEL); 6 miles [10 km] SE of Borden, 10 Sep. 1963, J.H. Willis (MEL); 11.6 km S from Ravensthorpe–Jerramungup road along Quiss road, 28 Sep. 1997, C.F. Wilkins CW1386, J.A. Wege, R. Butcher (PERTH, UWA).

*Distribution.* This species extends from Cowcowing to Twertup Creek in the Fitzgerald River National Park. (Figure 6B)

*Habitat.* This species occurs in brown sandy clay or loam, mainly with laterite, generally as an understorey shrub in *Eucalyptus* or *Allocasuarina* open woodland or shrubland.

*Phenology.* Flowering time is July to November, fruiting November to January.

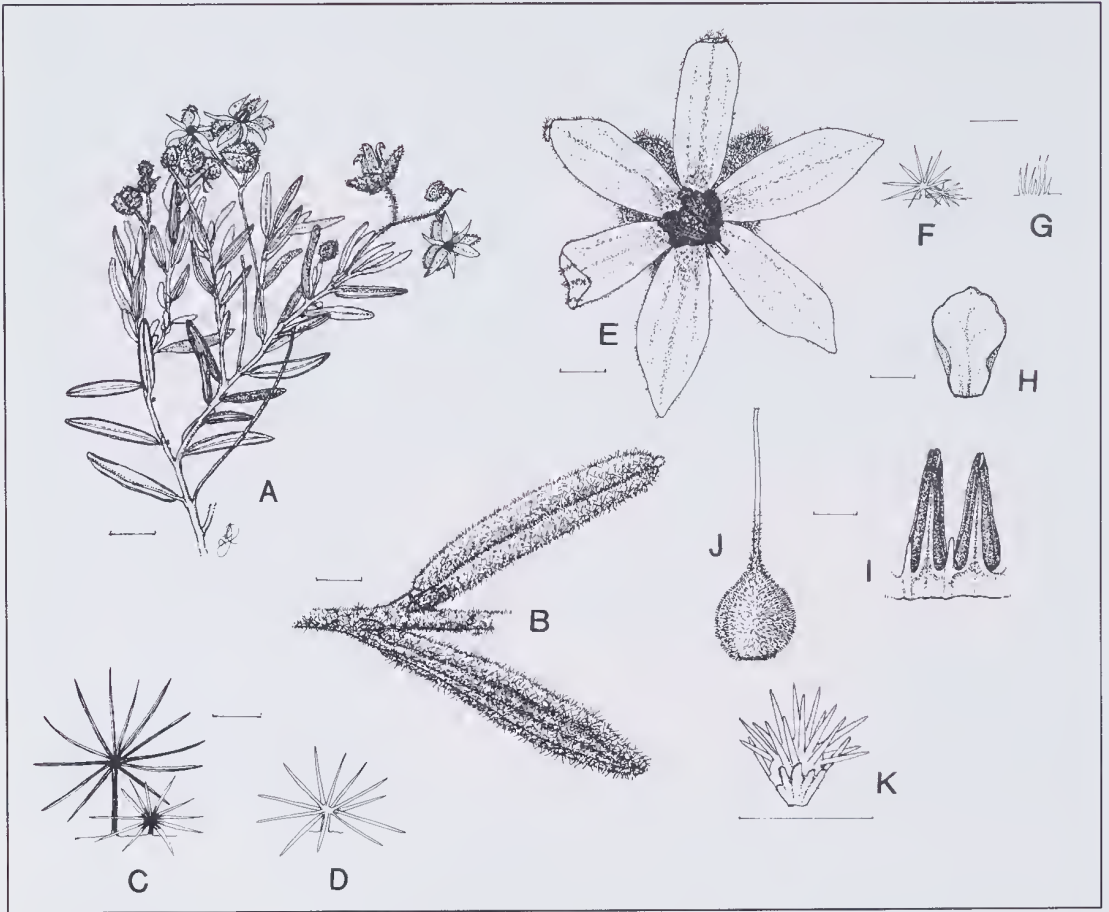


Figure 10. *Lysiosepalum involucreatum*. A - habit (scale bar (bar) = 1 cm). B - mature leaves (bar = 2 mm). C - stellate hairs on outer surface of bracteole. D - stellate hair on inner surface of bracteole (C & D bar = 0.1 mm). E - flower (bar = 2 mm). F - stellate hairs on outer surface of calyx. G - simple hairs on inner surface of calyx. H - petal (bar = 0.5 mm). I - adaxial surface of androecium. J - pistil (I & J bar = 1 mm). K - ovary hair (bar = 0.1 mm). Drawn from K. Shepherd 51 and C.F. Wilkins 1111.

*Chromosome number.*  $n=10$  (Figure 3).

*Conservation status.* This species has been poorly collected and mainly recorded as occasional or 1-3 plants, rarely frequent in the area. Conservation status deserves review after separation of numerous *L. hexandrum* from *L. involucreatum* collections.

*Etymology.* An involucre is a large bract or whorl of bracts; the epithet *involucreatum* presumably refers to the whorl of large epicalyx bracts covering the buds in this genus.

*Affinities.* This species is similar to *L. hexandrum* in having entire, rather than wrinkled leaf margins but differs in having the pedicels and epicalyx with an indumentum of long red-stalked stellate hairs instead of long red glandular hairs over short white stellate hairs, by having the epicalyx orange tan instead of greenish tan and petals that are rarely absent rather than rarely present.



**5. *Lysiosepalum rugosum* Benth.** (Bentham 1863: 267). *Type citation:* W. Australia. Swan River, Drummond. *Type:* south-west of Western Australia, *J. Drummond* (*lecto:* K, here designated; *isolecto:* MEL)

*Illustrations.* Grieve (1998: 653); Elliot & Jones (1990: 256).

*Shrub* to 1 m x 1 m, scent absent; young branches with close tomentum of sub-sessile or sessile, up to 24-celled, white with tan or brown-centred, stellate hairs c. 0.3 mm diam., glands absent. *Stipules* always present, sessile, c. 0.8 x 0.8 mm. *Leaves* mainly spreading or reflexed, only apical leaflets erect. *Petioles* 1–4 mm long. *Blades* grey, discolorous, narrowly ovate, 4–20 x 0.8–2 mm (young growth leaves c. 35 x 7 mm, stipules c. 3 x 5 mm), base cordate or sub-cordate, apex obtuse, margin crisped and scarcely recurved; adaxial surface strongly rugose with dense, sessile, white stellate hairs c. 0.4 mm diam. that become scattered or glabrous with maturity, glands absent, apical leaves white with brown spotted appearance; abaxial surface with a dense tomentum of yellow-tan stellate hairs to 0.5 mm diam., rib tan, (seedling and young plant leaves may have greenish white, not yellow abaxial surfaces) glands absent. *Inflorescence* 25–110 mm long, (2)4–6(8)-flowered; peduncle 9–25(50) mm long, with close tomentum of spotted appearance from short-stalked or sessile, white with tan- or brown-centred stellate hairs to 0.2 mm diam. *Pedicels* 5.5–7(11) mm long, with similar indumentum to the peduncle. *Bracts* linear or spatulate, 1.5–6 x 0.3–0.5 mm, adaxial and abaxial surfaces with dense tomentum of stellate hairs, glands absent. *Epicalyx bracts* scarcely fused at the base to 0.3 mm, ovate, 4–8.5 x 2.8–5 mm, apex acute; adaxial surface with scattered to medium density, sessile or subsessile, white, fine, stellate hairs; abaxial surface a close tomentum of stellate hairs, c. 0.4 mm diam., overall appearance either completely spotted from white hairs with brown or tan centres, or tan epicalyx bract base and apex spotted, rarely all tan. *Flowers* 6-merous. *Calyx lobes* ovate, elliptic or obovate, 5–10 x 2–6 mm, apex rounded or sub-acute; abaxial surface with sessile, white, fine, stellate hairs c. 0.25 mm diam., glands absent, ribs with additional medium density, short-stalked, stellate hairs to 0.4 mm diam. *Petals* erect, flat, dark red, 0.8–1.2 x 0.8–1 mm, or absent. *Androecium* dark red; staminodes absent or minute, triangular, c. 0.1 mm long. *Filaments* free or very shortly connate into staminal tube, 0.1–0.3 mm long; free portion 0.1–1 x 0.3 mm. *Anthers* 2–3.5 x 0.8–1 mm; pores becoming extended as longitudinal slits when mature. *Ovary* with stellate hair cells shortly fused at the base. *Style* 2–4 mm long, extending 0.7–1.3 mm beyond anthers; base glabrous or with few stellate hairs. *Fruit* c. 4 x 3 mm. *Seed* 1.5–1.8 x 0.9–1 mm. (Figure 11)

*Selected specimens examined.* WESTERN AUSTRALIA: near Indarra, c. 66 km E of Geraldton, 30 Aug. 1963, *A.M. Ashby* 256, (AD); Rockwell c. 55 km NE of Geraldton, 12 Aug. 1967, *A.M. Ashby* 2215, (AD, PERTH); 58 km SE of Mullewa on road to Morowa, 15 Sep. 1985, *B.J. Conn* 2156, (MEL, NSW, PERTH); Ballidu, date unknown, *M. Davis* 11011, (AD); Cowcowing, Sep. 1904, *M. Koch* 1180 *p.p.*, (P, NSW, MEL); 2.4 km NE of Canna Siding on Canna North East Rd, c. 40 km NNW of Morawa, 27 July 1996, *B.J. Lepschi* BJL 2730 & *T.R. Lally* (PERTH); 45 km NE of Cadoux, 20 Oct. 1990, *F.H. & M.P. Mollemans* 3476 (AD); Wongan Hills, 3 Oct. 1903, *A. Morrison* n.s., (BRI, PERTH); 1 mile [1.6 km] W of Moonijin, 23 Aug. 1965, *K. Newbey* 1994 (PERTH); Butters Boundary Rd, Northern end, Narembeen North, 7 Oct. 1986, *P.M. Olde* 822 (NSW); N of Canna, beside railway line, 15 Oct. 1986, *P.M. Olde* 890 (NSW); 7 miles [12 km] from Tardun towards Morowa, 1 Oct. 1962, *M.E. Phillips* s.n. (CBG); near Manmanning, 11 Sep. 1982, *B.H. Smith* 100, (MEL); 21.3 km W of Tammin, 24 Nov. 1994, *C.F. Wilkins* CW 732 (PERTH); 8.6 km W of Three Springs, 18 Aug. 1995, *C.F. Wilkins* CW 1013 (PERTH, UWA); 8 km E of Trayning, 22 Nov. 1995, *C.F. & S. Wilkins* CW 1149, *P. Dale & R. Orifici* (PERTH, UWA); 34 km NNE of Corrigin, 21 July 1984, *P.G. Wilson* 11924 (PERTH).

*Distribution.* This species extends from Rockwell (north-east of Geraldton) to Manmanning, Western Australia. (Figure 6D)

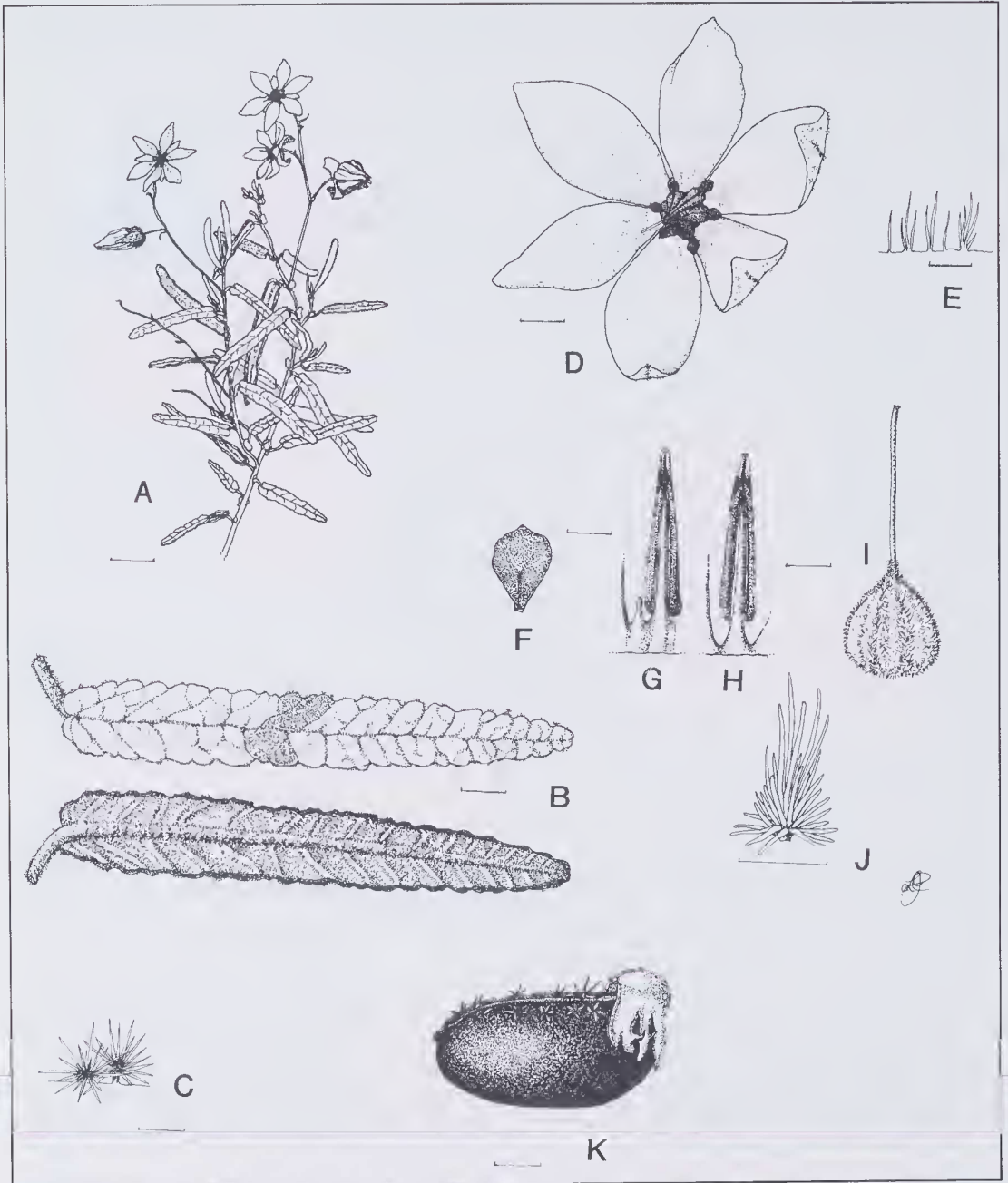


Figure 11. *Lysiosepalum rugosum*. A - habit (scale bar = 1 cm). B - leaf adaxial and abaxial surfaces (bar = 2.5 mm). C - bracteole abaxial surface stellate hairs (bar = 0.25 mm). D - flower (bar = 2.5 mm). E - hairs on adaxial surface of calyx (bar = 0.6 mm). F - petal. G - anther with staminode and staminal tube, adaxial view. H - anther with free filaments, adaxial view. I - pistil (F-I bar = 1 mm). J - brittle hair of ovary (bar = 0.1 mm). K - seed with aril (bar = 0.3 mm). Drawn from C.F. Wilkins 276.

**Habitat.** This species occurs in red-brown clay or loam with laterite, as an understorey shrub in open shrubland or open woodland.

**Phenology.** Flowering time is July to October. Fruiting period is October to February.

*Conservation status.* This species is widely distributed in remnant vegetation in wheatbelt areas and no special conservation status is recommended. Collections are, however, mainly recorded as populations of one plant or occasional, rarely as frequent in the area.

*Etymology:* The epithet – *rugosum* refers to the rugose “much wrinkled leaves”. A common name is Wrinkle-leaf *Lysiosepalum* (Grieve 1998).

*Typification.* The K material, comprising five moderately large specimens mounted on the same sheet and all apparently from the same collection, has been chosen as the lectotype. A single much smaller specimen at MEL, annotated as having been seen by Bentham, appears to be an isolectotype.

*Affinities.* This species resembles *L. abollatum* in having strongly rugose, narrowly ovate leaves but differs in having a close tomentum of small, sessile, stellate hairs rather than a woolly covering of long-stalked, large hairs.

*Notes.* The abaxial epicalyx bract surface on the type specimen has a short-stalked dense tomentum of stellate hairs with a spotted appearance from dark brown-centred hairs. Some specimens, however, have a tan-spotted or rarely overall tan appearance. These tan specimens are differentiated from *L. involucreatum* by having leaves with long petioles and adaxial surfaces that are rugose not smooth.

Close affinity to *Thomasia* is suggested by a putative cross-generic hybrid *T. formosa* Paust (K.A. Shepherd pers. comm.). *Thomasia formosa* has features of both *Lysiosepalum rugosum* and *T. macrocalyx* Steud., resembling the former in its coriaceous narrow leaves, white stellate-hairy ovary and elongated anthers, and the latter in its unilateral bracteoles, long calyx tube and broader calyx lobes. It is intermediate between the two putative parent species in having some flowers 5-merous like those of *T. macrocalyx* and others 6-merous like those of *L. rugosum*. All three taxa coexist at a Three Springs locality.

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